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Economic, Legal, and Institutional Issues

Earlier chapters have made the case that agricultural use of wastewater effluent and sludge, when appropriately treated (Chapter 3) and applied according to prevailing regulations or guidelines (Chapter 7), can be practiced satisfactorily with respect to public health (Chapters 5 and 6), crop production, and environmental concerns (Chapters 2 and 4). This chapter dis-cusses some of the economic issues, "residual risks", and other regulatory matters facing various interested parties involved in implementation. Residual risks are risks perceived by crop producers, food processors, and the public (such as local nuisance, food consumer safety, and agribusiness liability as examples) that persist despite federal (for sludge) and state (for effluent) regulatory safeguards. This chapter begins with an examination of the economic incentives driving beneficial reuse from the perspectives of society, the municipal wastewater treatment utility (also known as the "publicly-owned treatment works" or POTW), the landowner or farmer, and the food processor. Discussion then turns to key concerns about residual risks for the various groups. The chapter concludes with a review of the regulatory framework for food safety and environmental protection and its capacity to address the residual risks. Thus, the chapter provides an assessment of the adequacy of existing economic, legal, and regulatory mechanisms for addressing these outstanding concerns.

ECONOMIC INCENTIVES FOR LAND APPLICATION OF TREATED MUNICIPAL WASTEWATER AND SLUDGE

Interest in reclaiming treated wastewater effluents is being driven by two major factors. One is the increasing cost of water supplies in many metropolitan areas, especially the arid western United States. For example, the wholesale cost for fresh water in Southern California can exceed $800/acre-foot ($2.45/1000 gal), depending on the treatment requirements and the distance from the source; by comparison, most types of water reclamation cost much less than $750/acre foot (Water Reuse Association of California, 1993). The second factor is the growing volume of wastewater (as shown in Figure 1.1) and the increasing cost of complying with water pollution control regulations governing wastewater discharges into the environment. This is especially apparent where excess nutrients from discharged wastewaters can cause water quality

problems. For example, the sensitivity of aquatic habitats in Florida prompted the City of Orlando and Orange County to develop, as an alternative to surface water discharge, the CONSERV II program which combines wastewater irrigation on citrus groves with ground water recharge (D'Angelo et al., 1985). In St. Petersberg, Florida, water reclamation also began based on disposal requirements; however, the reclaimed water now has a greater value as a substitute for scarce potable water drawn from aquifers 50 miles away. Driven by economic and environmental concerns, and encouraged by the similarity of treated wastewater effluents to irrigation water, the use of reclaimed wastewater for agricultural irrigation is potentially com-petitive with other sources of water and can be a cost-effective alternative to wastewater discharge in selected parts of the country.

Generation of sewage sludge likewise has been steadily increasing in this country as a result of higher treatment levels and greater quantities of wastewater from continued population growth. Municipalities have used various options for the disposal of sewage sludge, including landfill, incineration and ash disposal, ocean dumping, and land application. The public reaction in 1988 to the appearance of medical wastes along New Jersey shores (Spector, 1992) led to the enactment of the Ocean Dumping Act (P.L. 100-68) that included a ban on ocean disposal of sewage sludge. The limited capacity of sanitary landfills is quickly exhausted, and communities are not providing for new landfills. Air quality requirements for incineration plants are increasingly stringent. Because of the these restrictions, the Bureau for Clean Water, which handles waste-water treatment for New York City, must spend approximately $800/ton to ship its sludge out of state (Wagner, 1994). As society has continues to reevaluate and regulate disposal options, agricultural use of sludge is becoming an increasingly attractive option because of its low cost and because of the fertilizer and soil amendment properties of sludge (see Chapter 4).

The following sections describe economic issues relating to the use of both reclaimed treated wastewater effluents and treated sewage sludge from the perspectives of the various parties affected by agricultural use projects. The specific costs and benefits are site specific; thus, no generic assessment of the tradeoffs is possible. The focus of this study is on the use of treated effluents and treated sludge in the production of food crops, and no comparative assessment is made of the economics of other use or disposal alternatives for sludge and waste-water.

POTW Economic Perspectives

The alternatives available to POTWs for treatment and ultimate release of wastewater and sludge into the environment are circumscribed by the Clean Water Act and by state and federal regulations for solid waste disposal. Thus, POTWs face the problem of deciding which of the available options for treatment and disposal of the sludge and wastewater are most appropriate and cost effective for their particular circumstances.

Cost-effectiveness analysis (Baumol and Oates, 1988) is an analytic tool commonly used by POTWs in choosing among available options for wastewater management. The major cost components of conventional wastewater systems include collection, treatment, wastewater discharge, and disposal of sludge (Milliken, 1990). Direct cost factors include the characteristics of the wastewater, type of treatment, size of facility, location, and type of sludge treatment, and ultimate disposal or reuse method. The costs of performing these functions include capital costs for building the facility, and annual operation and maintenance costs. The capital costs are generally amortized over the life of the facility in order to arrive at an annualized capital cost. Most POTWs in the United States are required to perform a minimum of secondary treatment (see Chapter 3), and this can be considered as a baseline for POTWs in considering a change in their function from providing wastewater disposal to reclamation. Only the ad-ditional level of treatment and other costs associated with changing to water reclamation options need to be considered. However, in some areas (e.g., Florida), land application of wastewater may allow for lower levels and costs of treatment compared to surface water disposal due to the advance treatment that would be required to remove nutrients from effluents prior to discharge into sensitive surface waters.

The Florida Department of Environmental Regulation (1991) issued guidelines for the economic evaluation of implementing water reuse projects. The feasibility guidelines require the comparison of the net present values of alternatives (including the current practice) over a 20-year period. Capital construction costs are to include the cost of wastewater collection and treatment, and reclaimed water transmission to the point of delivery for the end user, plus reasonable levels of related costs such as engineering, legal service, and administration. Annual operation and maintenance costs must also be calculated for each alternative. Effluent irrigation alternatives generally require additional costs for effluent collection, advanced treatment, trans-portation to reuse sites, irrigation management, and water storage.

State requirements for wastewater effluent quality vary depending on the type of crop and irrigation method. The U.S. Environmental Protection Agency suggested guidelines (EPA, 1992) for water reuse include secondary treatment plus disinfection for nonfood crops, com-mercially processed food crops, and surface irrigation of orchards and vineyards. Secondary treatment plus filtration and disinfection is suggested for irrigation of food crops that are not commercially processed and that could be eaten raw.

An analysis of the cost of supplying reclaimed water to agriculture was recently com-pleted in the Tampa, Florida area (Hazen and Sawyer, 1994). Treatment included filtration and chlorination of secondary treated effluent. Additional costs included 2.5 million gal of storage for every 10 million gal/day of capacity and transmission costs of $.35/1000 gal. Total costs of supplying reclaimed water to agriculture were estimated to range from $.70 to $.90 per 1,000 gal (approximately $225 to $300 per acre-foot). For comparison purposes, farmers typically pump water directly from the aquifer at a cost of approximately $.10 to $.15 per 1,000 gal. Water obtained from the water utility service is at the same order of magnitude at $.82 to $1.06 per 1000 gal. The cost to the farmer will depend on whether reclaimed water is used to comply with water quality regulations, which is the case in Orlando and Tallahassee, or whether reclaimed water is used to offset short supplies of water, as in Tampa. Incentives to the farmers will not be needed in water-short areas, but may be needed in other areas where water quality concerns drive the reclamation effort.

There are a variety of economic approaches and market alternatives that POTWs may use to offset current and future costs of supplying reclaimed water. If water reclamation results in a reduction in the demand for current potable water—i.e., if agriculture is drawing on an existing or potential potable water supply—the reduction should be valued at the average rate charged for potable water in order to determine the benefits of the reclaimed water. If the re-claimed water is sold, then revenue from the sale of reclaimed water may be available to offset reclamation costs. Finally, the POTW may decide to own and manage agricultural land for land disposal of wastewater effluent. In this case, revenue from the sale of commodities produced may be available to help offset reclamation costs. For example, the city of Tallahassee, Florida owns a 1,720 acre agricultural operation that accommodates an average of 12 to 18 million gal/day of effluent (Roberts and Bidak, 1994).

The implementation of any wastewater reclamation plan may allow the community to avoid or delay the cost of expanding potable water supply systems, and potential cost savings should be included in the economic analysis of water reclamation alternatives. A study by the Irvine Ranch Water District in California showed that, while the 1987 wholesale cost of treated fresh water (at $230/acre-foot) was less that the cost for water reclamation (at $303/acre-foot), it was projected that wholesale water costs would rise to $449/acre-foot (calculated in 1987 dollars) by the year 2000 because of rising demand and system expansion (Young et al., 1987). Water reclamation would allow the community to avoid the need for water supply expansion and thus save $146/acre-foot.

Sludge handling is an important aspect of POTW operations. Evans and Filman (1988) indicate that sludge handling costs accounted for an average of 47 percent of the total treatment plant costs for four large treatment plants in Ontario, Canada. Some of the processes that are used include thickening, dewatering, drying, conditioning and transportation (as described in Chapter 3). The EPA handbook, *Estimating Sludge Management Costs* (EPA, 1985) describes a number of different unit processes that can be used to achieve each of these various steps and provides generic comparative cost curves as well as specific algorithms for calculating unit costs for each process. However, the large number of processes that can variously be combined into any particular sludge management train, and the site-specific nature of the costs of implementing many of these processes, prevents meaningful generic cost comparisons. For example, the Evans and Filman (1988) study compared sludge handling costs for four treatment plants with different sludge handling processes, but all subject to identical effluent disposal requirements. Total sludge processing costs ranged from $266/ton to $925/ton depending upon the specific unit processes employed for sludge treatment.

Treatment procedures and quality criteria to be met for various types of end uses or dis-posal of sludge are specified in the *Standards for the Use and Disposal of Sewage Sludge* (or "Part 503 Sludge Rule", EPA, 1993). Effective pollutant source control and industrial pretreatment programs will be required to meet EPA requirements for high-quality pollutant concentration limits. Specific processes are necessary to meet the Class A pathogen reduction levels. The advantage of meeting these higher-quality sludge requirements is that the sludge can be applied to agricultural land with lower costs for regulatory compliance.

Sludge transportation can be a significant cost of land application. Transportation costs depend primarily on the quantity of water in the sludge and the distance transported. As de-scribed in Chapter 3, sludge volume can be reduced by thickening, dewatering, conditioning, and drying. Dick and Hasit (1981) discuss the tradeoff between additional treatment costs to reduce sludge volume and the savings in transportation costs. This tradeoff depends upon the distance the sludge is to be transported, the mode of transportation, and the cost of reducing sludge volume. The Madison, Wisconsin Metrogro Program determined that agricultural use of liquid sludge was the least expensive alternative since they had access to over 30,000 acres of farmland within a 20 mi radius of the POTW (Taylor and Northouse, 1992).

Comparisons of sludge management alternatives, should include the potential, if any, of revenue from beneficial land applications. Sludge contains nutrients and organic matter that can substitute in part or whole for commercial fertilizers or soil amendments (e.g, see Table 2.2). The Madison Metrogro program charges farmers $7.50/acre of sludge applied (Taylor and Northouse, 1992). Their application rates are determined by the most limiting factor, either crop nitrogen requirements or regulatory levels for metals. However, income generated from this fee covers only 1-2 percent of total program cost. The fee charged to farmers exists primarily to reinforce the concept that sludge is a beneficial product rather than a waste. Since 1979, Metrogro has recycled 139,000 tons of dry solids, with a total fertilizer value of over $2 million. Farmers' demand to participate in the program far exceeds the District's ability to sup-ply sludge and is indicative of the local value of sludge as a soil amendment product.

Farm Economics of Treated Wastewater and Sludge Use

A farmer considering the use of reclaimed wastewater or sludge will initially have several concerns, including the potential health risks to family and employees, potential toxic effects on the plants, long-term detrimental changes in physical or chemical properties of the soil that may affect crop production, the potential liability associated with the sale or consumption of crops grown using wastewater and sludges, and the fear of liability for contamination of the land with hazardous wastes. Sewage sludge is not listed as a hazardous waste under the Resource Con-servation and Recovery Act (RCRA) unless it exhibits characteristics that make it a hazardous waste and prevent its beneficial use (EPA, 1993). This last issue has been of concern to farm bank lenders who have a financial interest in the value of the land. These concerns, which are reviewed in the next section under "Managing Residual Risks," will have to be addressed before growers will even consider whether using wastewater or sludge is profitable or not.

Only after these concerns are adequately addressed will farm economics come into play. Treated wastewater and sludge provide inputs (water and nutrients) to agriculture. The demand for these inputs will depend on their relative contribution to production—also known as "marginal productivity"—and the price of the crop. The cost and availability of substitute sources of fertilizer or irrigation water provide ceilings to the price the farmer will pay for the nutrients and water in the treated effluent. In general, the greater the marginal productivity and the higher the price of the product, the higher will be the marginal value of the crop and the willingness-to-pay for water or nutrients. The agricultural marginal value for irrigation water is quite variable. In the early 1980s, the congressional Office of Technology Assessment (1983) estimated that the values of water for irrigated agriculture ranged from $9/acre-foot for pasture to $103/acre-foot for vegetables (these 1983 estimates would be about 50 percent larger in 1995 dollars.) Boggess et al. (1993) provide a comprehensive discussion of the economics of water use in agriculture. Moore, et al. (1985) provide a detailed assessment of the on-farm economics of reclaimed wastewater irrigation in California (also see the discussion of irrigation water value in Chapter 2).

The value of the nutrients will depend primarily on the relative levels of the various nu-trients in the water and the nutrient requirements of the crop. Estimates for the CONSERV II project in Florida place the total value of nutrients in the reclaimed water at $100 to $250 per acre per year (D'Angelo et al. 1985), which is equal to or exceeds current farm fertilizer costs of approximately $100-$120 per acre (Muraro et al., 1994). Because fertilizer costs generally do not exceed 10 percent of total farm costs, and because its application through irrigation is not as easily controlled as through conventional fertilizers, it is not likely that farmers will place much value on the fertilizer benefits of reclaimed water. Additionally, nutrients in wastewater effluent may present a problem for some crops at certain stages of growth as discussed in Chap-ter 4.

Whether or not reclaimed wastewater can be marketed to agriculture also depends on the cost and availability of reclaimed water relative to other sources of irrigation water. Supply considerations include seasonality and storage as well as the on-site delivered cost of reclaimed water. Florida, for example, receives an average of 50 in. of rain per year, but irrigation is critical for the production of high-value crops. This is due to the low water-holding capacity of the soils, the high evapotranspiration rates, and irregular timing of rainfall events. Estimates for the CONSERV II project indicate that growers save from \$75 to \$150/acre/year in irrigation costs (D'Angelo et al. 1985). However, this estimate is based on the total amount of water sent to the growers in the CONSERV II program, which is in excess of what they would normally use. Typical irrigation costs for growers pumping ground water in the areas are estimated at \$30 -\$70 per acre (Muraro et al., 1994). Nevertheless, growers in the CONSERV II project have not been required to pay for the new water supply because water sources in the area (from ground water) are inexpensive and easily accessible, and more importantly, because the CONSERV II project was initiated by the county and city to avoid the higher cost of complying with the water quality requirements for discharge, not because water is a scarce resource.

Where effluent irrigation projects are motivated by disposal, farmers may resist applying water to oblige the utility. In addition, farmers will be concerned about whether sufficient water will be available during periods of peak need, or whether or not they will be required to take water in excess of their needs. These concerns were worked out in the CONSERV II project in Florida (D'Angelo et al. 1985). The citrus grower participants in the project have agreements that require them to take a total of approximately 50 in. of water per year even though typical irrigation rates are only 12 to 24 in. per year. The contract allows the grower to refuse delivery of scheduled quantities of water for a limited number of periods each year. In addition, the City of Orlando and Orange County agreed to provide additional wells to the farmers to insure adequate water to protect crops from freezing, since the supply of treated effluents would be inadequate during these peak use events. In accommodating the seasonal nature of water demand, the POTW developed a series of rapid infiltration basins for ground water recharge. This option allows the POTW to divert excess effluent to the recharge basins when crop irrigation needs are low.

Sewage sludge has value to the farmer for its nutrient content and as a soil conditioner. The market demand for sludge will depend on the marginal productivity of sludge, the cost of alternative sources of nutrients or soil amendments, and regulatory and permitting costs. The marginal productivity of sludge varies with the soil and type of crop. Crop yields will show greater responses to sludge applications on those soils which are poor in nutrients and organic matter (see Chapter 4). Likewise, certain crops require greater quantities of nutrients. Thus, from a strictly economic perspective, the willingness-to-pay for sludge should be positively related to the crop's nutrient requirements and inversely related to the inherent fertility of the soil.

The availability of low-cost commercial fertilizers will generally be a limiting factor on farmers' willingness-to-pay for sludge. The nitrogen content of sludge usually ranges between 1 and 4 percent, which would be worth roughly \$6-\$24 per dry ton, given 1994 prices for commercial bulk nitrogen fertilizers. Other nutrients in sludge, such as phosphorus, may also contribute to its value (EPA, 1994). Metrogro, the sewage sludge agricultural use program in Wisconsin, estimates an average fertilizer value of \$15/dry ton of sludge (Taylor and Northouse, 1992). Farmers will also be concerned about the mix of nutrients in the sludge relative to the crop's needs. While sewage sludge can supply all crop nutrients if applied according to nitrogen requirements, fertilizer application rates are not as easily controlled as with commercial products and supplemental fertilizer may be needed in some instances to meet the crop's requirements (see Chapter 4).

Other economic considerations for the farmer include the cost of applying sludge and the additional monitoring, recordkeeping, and management required by federal, state, and local regulations. However, some or all of these costs are typically incurred by the contractor and/or POTW. Conversely, the POTW may choose a higher level of sludge treatment and thus reduce other regulatory requirements. Treatment and regulatory costs incurred by the POTW, may be passed on to the public in the form of higher rates. Regulatory and some monitoring costs are generally incurred by public agencies, and thus, taxpayers. Other management and monitoring costs are borne directly by sludge handlers and users.

In some cases, the costs associated with monitoring, handling, and recordkeeping requirements may equal or exceed the direct economic benefits of land application, even though land application may be the environmentally preferable and the most cost-effective alternative from society's point of view (i.e. when all direct, indirect and social costs and benefits are considered). In these cases, it may be necessary and appropriate for the POTW to subsidize private sludge handlers and users in order to offset these costs. However, care should be taken to insure that the subsidy payments are properly structured and don't create incentives for "dumping" or application of sludge at rates exceeding appropriate agronomic levels. Subsidies also can obscure beneficial value and create the illusion that sludge is a waste product that farmers have to be paid to accept. As earlier mentioned, the Madison Metrogro program solved this problem by having the POTW incur the costs for transporting the sludge to the farm site, injecting it into the ground, and perform the monitoring recordkeeping. Farmers pay $7.50/ acre, which pays only a small portion of program costs, but helps to reinforce the notion that sludge is beneficial product.

Benefits of crop productivity and cost savings have been documented in individual cases. In western Washington state, the Wegner farm has been applying sludge from Spokane since 1988 at 4.5 dry tons/acre/year (Logsdon, 1993). The sludge, in the form of wet cake, is in-corporated into the soil before the growing season. Wegner reports 35 percent increases in yields (and increased protein content) of barley and wheat and a fertilizer savings of $12 to $25 per acre.

Food Processor Perspectives

To survive financially, food processors and retailers must have a demand for their food products and fill it economically. Thus, anything that may affect the demand for their products or their cost of production is of concern. The use of wastewater and sludge may reduce the cost to the buyers of raw food products if growers are able to reduce their costs, increase pro-ductivity, and sell their crops at a more competitive price. However, the impact of using treated effluents and sludge on the cost of producing food crops is likely to be quite small for two reasons. First, as discussed in Chapter 2, the extent of wastewater irrigation in agriculture represents much less than one percent of irrigated crops and is not likely to increase, due to the limited availability of cropland close to wastewater treatment plants, and the competing (mostly urban) uses for reclaimed water in those areas where reclaimed water has value. For sludge, even if all of the sewage sludge produced in the United States were land-applied to agriculture, these inputs would provide nutrients for less than 2 percent of cropland. Secondly, the value of sludge and wastewater as fertilizer will be no more than 10 percent of the total costs of farm production. As a result of these scale effects, land application is not likely to have significant impact on the average cost of growing food. Finally, from a farmer's perspective, the potential problems associated with sludge and wastewater could quickly outweigh the benefits. These factors will limit any cost savings that could be passed on to food processors as an incentive to purchase from farms that apply wastewater and sludge.

The potential liabilities or costs associated with the use of treated effluents and sludge for food processors stem from the public perception that adverse health effects could result (for example, the concern over Alar pesticide in apples, bovine growth hormones in milk, or conversely, the popularity of foods labeled as "organic"). Nevertheless, public perception does not necessarily depend on objective, scientific evidence. As discussed in Chapter 7, negative human health effects from the consumption of food crops are unlikely under the Part 503 Sludge Rule or under state regulations for effluent irrigation of crops. Still, food processors and retailers are particularly concerned about potential liability for health risks attributed to the consumption of food grown with the use of treated wastewater effluents or treated sludge. They require evidence to convince them that all aspects of the process are being carefully managed according to the regulations and guidelines, and that there is adequate oversight and enforce-ment.

MANAGING RESIDUAL RISKS

It is important to consider management and program oversight before embarking on reuse alternatives for both wastewater and sludge. Acceptance of the practice by the local community and farmers, and the public's confidence and trust in the public utility is a prerequisite to program success. As discussed in the following sections, concerns over public health, food safety, neighborhood nuisances, community land values, marketability of crops, sustainability of farmland, and the reliability of safe farming practices are important implementation issues. These all need to be adequately addressed, and will impose new burdens on agencies and the private parties involved. The capacity of the POTW to undertake an agricultural-use project in this context is an important threshold consideration. Florida, for example, limits water reuse projects to larger POTWs because smaller facilities may lack the staff and finances to do an adequate job (Ferraro, 1994).

Residual Risks

The purpose of EPA's Part 503 Sludge Rule and state regulations on wastewater irrigation are to assure safe use of sludge and wastewater in agriculture. In addition, numerous other regulatory programs are designed to protect the environment from agricultural contam-ination and protect consumers from adulterated foods (as discussed later in the chapter).

Nevertheless, many concerns have been raised about the "residual risks" of using sludge and wastewater in agriculture—those risks that may persist despite the regulatory safeguards. These concerns include potential risks to:

· the health of persons and livestock who consume foods produced with treated sludge and treated wastewater effluents;

· the health of agricultural workers and other persons on agricultural sites where sludge and wastewater are used;

· the health of persons who consume ground water, surface water, or fish or shellfish from areas where sludge and wastewater are used;

· the quality of life and value of property of nearby residents; and

· the quality of natural resources, such as agricultural soil, rivers, wetlands, ground water, flora, and fauna.

While only the first concern—that of health effects from food crops—is the main focus of this report, the implementation of agricultural use programs for wastewater effluents and sewage sludge will ultimately depend on the degree to which all of these concerns are addressed. Business risks and burdens also arise from these concerns about residual risks, making farmers and food processors reluctant to produce and process foods grown with the aid of sludge and wastewater, and making retailers reluctant to sell these foods. The business risks may outweigh any benefits that farmers gain by using these materials. For example, community concerns can lead to enactment of local or state regulations that prohibit agricultural use of sludge or wastewater in certain regions, or impose new and costly technical safeguards and monitoring duties. On a national scale, consumer concerns about the safety of crops grown with sludge or wastewater can stimulate consumer and retailer boycotts of certain products, new labeling requirements (which tend to stigmatize such products), and new food inspection and reporting procedures.

In addition, several banks that finance farmers in the northeast have been concerned about whether repeated applications of sludge containing toxic substances (such as cadmium and lead), even at the levels set by EPA's Part 503 Sludge Rule, could potentially put a farm at risk of becoming a hazardous waste site and create cleanup liabilities. These lenders have an interest in protecting the value of the farmland that secures their loans, and are concerned about whether they would be designated as "responsible parties" liable for the cleanup costs. After studying the issue, the Farm Credit Institutions of the Northeast (an organization of farm credit banks) determined that assurances may be needed to cover the economic risk. They proposed that farmers seeking their loans through mortgage financing should make sure that the POTW that provides them with sludge will indemnify them in the event of hazardous waste liabilities that result from application of the sludge (Benbrook and Allbee, 1994).

Other business risks pervade the sensitive markets for food products. Farmers and food processors are affected when a court or agency finds that its food product is contaminated and has caused, or is likely to cause, personal injury to consumers or livestock. Such determinations can rapidly lead to economic losses in the form of agency impoundment and destruction of the products, regulatory penalties, tort liability in the form of compensatory and punitive damages for personal injuries, and contract liability for breach of product warranties.

But the major business risk for farmers and food processors in such instances is stigmatization of the product and its source. This leads to loss of customer confidence, choice of competing products, and loss of market share on regional and even national scales. Even if contamination or injury causation is unproved, these consequences may occur because widespread media coverage, speculations, or allegations may be enough to make retailers and consumers reject the product.

Thus, public concerns about residual risks create business risks and militate against agricultural use of sludge and reclaimed water despite the regulatory safeguards provided by federal and state agencies. Proponents of sludge and wastewater use must, therefore, address the sources of such public concerns if they are to achieve their goals.

Public Concerns to be Addressed

Public concerns fall into several categories. One category consists of "nuisance" risks to community quality of life and property values, such as odors, traffic, and the attraction of vermin to sludge application sites. Another category of concern has to do with protection of nearby natural resources of high value, such as wellwater, other water supplies, and fish. It is common experience that such resources are highly vulnerable to agricultural contamination (e.g., from pesticides). Consequently, local opposition to specific projects and general public concern are not uncommon, especially where there has been a limited history of relatively safe use (see Zimmerman et al., 1991; Gigliotti, 1991; Business Publishers, Inc., 1993). Some states may limit the ability of local authority to place restrictions on practices that are allowed by the state. Small community governments have a limited capacity to deal with all the issues that are raised, and local residents may feel threatened. For example, the residents of New Harmony, New Jersey have been plagued by odors from an adjacent farm, which appears to be a dumping ground for both municipal sludge and food processor wastes (Markle, 1994). Also concerned about environmental impacts, the New Harmony residents have been repeatedly frustrated in their attempts to bring their concerns to the attention of state regulators who permit the farm for application of in-state and out-of-state sludge.

Elsewhere, these types of public concerns have already led to enactment of local ordinances banning or restricting sludge application, as in Merced County, California (Sludge Newsletter, 1993). Such ordinances have survived legal challenges where they are not pre-empted by federal law and are within the broad scope of the "police power" possessed by state and local governments. For example, a federal district court ruled that a Virginia county ordinance completely banning the land application of sewage sludge as a method of disposal is not preempted by federal law and does not interfere with interstate commerce (Welch v. Rap-pahannock County Board of Supervisors, DC WSVA, No. 94-002-C, May 24, 1995).

The POTW and cognizant officials must provide the public with assurances that meet such concerns. Studies have shown the importance of bringing the public into the decision-making process at an early stage for this purpose, and the importance of informing the public of the results. Necessary assurances may include a demonstration of stringent self-regulation and monitoring by state and local agencies; reliable management and reporting by the POTW, contractors, and farmers; and vigilant enforcement by regulatory agencies. In particular, there must be assurance that the beneficial use program has credible means of preventing nuisance risks and harm to the nearby resources of high value. Visible demonstrations have been shown to be effective in making people aware and comfortable with reuse projects. Moreover, it is unlikely that insurance, liability, indemnification, or other compensation for harms would be sufficient to offset such public concerns.

In Chapter 7, questions were raised about EPA's approach to screening toxic organic pollutants and their exemption from regulation. While the committee concluded that these organic pollutants in sludge were not likely to present a risk to consumers of food crops, public concerns have been raised by the fact that even a small percent of sludges have concentrations of certain pollutants (e.g., PCBs) that exceed a risk-based limit of acceptability. In addition, it is difficult for the public to understand that the application of sludge on cropland is safe when ocean dumping of sludge is prohibited even though the major reason for prohibiting ocean disposal of sewage sludge had to do with excess nutrient loads on marine ecosystems rather than toxic pollutants or beach safety concerns. Other questions have been raised about the safety of wastewater effluents and sludge. A recent report by the General Accounting Office (1994) dealt with the presence of radioactive material entering sewage treatment plants and the lack of regulatory action on this issue. This committee has not delved into that particular issue or other issues involving the quality of municipal wastewater, but it is possible that such concerns will arise when a POTW elects to recycle wastewater or sludge on cropland. Addressing such con-cerns about sludge requires convincing scientific analysis showing that adequate safeguards are being applied.

Finally, some of the concerns about the use of sludge in agriculture are based on a lack of confidence in the ability of federal and state government to adequately enforce regulations that have been enacted to safeguard health and the environment. In addition, farm management is not regulated by the Part 503 Sludge Rule. As with other fertilizers or soil amendments, farmers are expected to use good farming practices that prevent the nutrients in sludge from causing water quality problems. When using sludge of lower sanitary quality ("Class B" sludge), the Part 503 Sludge Rule requires a statement by farmers that they understand and have complied with restrictions on the type of crops used and necessary waiting times prior to harvest. The public health impact of using Class B sludge on farms is protected if the farmer follows these restrictions and guidelines (see discussion in Chapter 7). However, the Part 503 Sludge Rule does not regulate potential water-quality impacts that are broadly covered by the Clean Water Act (EPA, 1993, and see discussion later in this Chapter), and farm management is not easily enforced. These public concerns must also be addressed by state and local authorities.

Risk Management: Private Sector

Private sector forces have the potential to deter inappropriate behavior by the parties in-volved in the production, treatment, and use of sludge and wastewater. These include: (1) common law liability, (2) market forces, and (3) voluntary self regulation. Taken together, the private sector forces and regulatory programs have the potential to minimize the residual risks and possibly to dispel public concerns.

Common Law Liability

As with many products, liabilities for personal injury and property damage can arise at various stages in the life cycles of treated sludge and treated effluents, such as when the product is put to use, when it becomes a component of other products (crops and derivative foods), when the subsequent products are consumed as foods by consumers, and when the product wastes are disposed. In the event that the primary or derivative products or their wastes are found to cause harm to consumer health, property, or resources during any part of the life cycle, it is likely that liability, in the form of compensatory and punitive damages, will be imposed by the courts in accordance with the tort and product liability doctrines of state common law. In the case of en-vironmental problems, regulatory penalties and cleanup costs may also be imposed.

For example, if harm befalls a consumer of a product that was produced with sludge or wastewater, the farmer or food processor may incur liability for negligence if it is shown that they failed to meet the prevailing standard of care in their field of activity. Parties who produce or sell food products are held to a particularly high standard of care and are thereby especially vulnerable to negligence actions. They are even more vulnerable in those states that hold that failure to meet a regulatory requirement constitutes negligence per se, obviating the need for the victim to prove negligent conduct.

Personal injury claims by food consumers may also be brought against farmers or food processors under a state's strict product liability doctrine for selling a "defective product." According to this doctrine, a defective product is one that is unreasonably dangerous due to faulty design or manufacture (e.g. due to a breakdown in POTW treatment, in farm management practice, or in food processor quality control) or due to inadequate warnings of latent risks of the product or inadequate instructions for its safe use. In such cases, farmers, food processors, and even POTWs are particularly vulnerable to liability because the victim need establish only that the product was defective and that the defect caused the injury, and is not required to prove negligent conduct, a more difficult task.

Liability may also arise from nuisance claims by owners of neighboring property, such as when sludge or wastewater contaminates or otherwise impairs (e.g. via odors) their use and enjoyment of their property. Liability can arise from claims of breach of contract warranty (express or implied warranty) regarding the fitness of the product for use in the production of food or as a constituent part of a processed food for human or animal consumption.

Finally, claims of inverse condemnation may be brought against POTWs by farmers whose land is contaminated by improperly treated sludge or wastewater provided by the POTW. Such a claim could be based on the constitutional doctrine that prohibits governmental "taking" of private property without just compensation. An inverse condemnation action would be a possible means of securing compensation for property damage from a governmental organization (such as a POTW) despite laws in many states which establish governmental immunity from tort claims.

As a result, farmers and food processors face potential liability for compensatory and punitive damages under the common law for a broad range of harms that might occur throughout the life cycles of treated sludge and wastewater. Liability should make these parties act re-sponsibly when engaging in agricultural and food production practices that use sludge and wastewater. Insurance and indemnification agreements are helpful and may cover or shift liability to other parties; however, these devices are incapable of reducing the stigma and loss of customers that usually follows from liability claims. The economic consequences of high-profile accusations can be more severe than the liability itself.

Thus far, the risk of common law liability has been too high for some food processors and some farmers, and has contributed to their reluctance to use sludge and wastewater as part of food crop production for processing. A longer term view is that liability potential will induce care, and in the case at hand, will not be viewed as a deterrent to sludge or wastewater use when the parties have sufficient confidence that their practices will not incur liability. Development of such practices is aided by regulatory requirements. It is also aided by voluntary self-regulation, as discussed below.

Market Forces

When treated wastewater is reclaimed to meet water supply demand in regions where natural water supply is inadequate, the treated effluent has economic value. This value should support investment by the POTW seller in reliable treatment systems, and other expenditures to minimize risks, such as proper application and use, by the farmer who purchases it. Accord-ingly, risks in this "strong market" scenario are likely to be adequately controlled.

A different scenario arises when agricultural use of wastewater or sludge is being promoted by the POTW in order to facilitate disposal and reduce disposal costs, as in cases where environmental constraints limit other disposal options and there is no local demand for the wastewater. In such cases, the wastewater is without economic value and its subsequent disposal by means of agricultural use may have negative economic value because of the ex-penditures that will still be required for its treatment and safe use. If POTW cost avoidance is the rationale, farmers, community residents and others may be concerned about the POTW's responsibilities and require special assurances.

Once sludge or wastewater has been used to grow crops, market forces arise that may act to reassure consumers about the safety of food products. As discussed earlier, farmers and food processors operate in safety-conscious markets. Thus, once a farmer has accepted sludge or wastewater, the market forces should act to assure that appropriate farm management practices are followed, and that effective quality control methods will be used by food pro-cessors, since both parties have so much at stake. Experience of the marketability of crops grown with reclaimed water in California with food brokers and buyers for food chains show no reason for separate labeling, low business risk, and a good track record with no incidents (The Marketing Aim, 1983). However, in other cases, this market force has been perceived as both a cost burden and business risk, which many farmers and food processors are unwilling to assume. Voluntary self-regulation of sludge application by farmers and food processors, in the form of codes of conduct and self-imposed management practices, could help to mitigate neg-ative market force effects, as discussed below.

Voluntary Self-Regulation

Self-regulatory programs are being developed in many business sectors to help companies comply with regulations, avoid liability, and to help customers use products safely. Although company conformance to such guidance is voluntary, failure to conform marks a company as one that does not meet the prevailing industry standard of care or its state of the art for managing risks. Conformance to the standard is promoted by the potential of adverse economic consequences of nonconformance (e.g, loss of customer confidence, heightened potential for negligence liability, and regulatory action in the event of an injurious outcome).

Food processors currently protect themselves by having an official position of not purchasing food from farms that use sludge or wastewater (National Food Processors Asso-ciation, 1993). However, food processors and farmers have the opportunity, through their various associations, to develop new guidance for quality control and farm management practices that can reduce the residual risks of using treated sludge and wastewater. Such guidance, if followed, could have the further effects of mitigating public concerns about regulatory in-adequacies, and mitigating business concerns about liability.

Successful self-regulatory programs are available as models. They include private sector training and certification programs, self-auditing, independent third party evaluation of per-formance, and specific practices for risk management.

Although such self-regulation and codes of conduct are developed within the private sector, government agencies such as EPA and U.S. Food and Drug Administration could provide encouragement and generic guidance to assure their proper design. The agencies could also provide various incentives for such self-regulation, such as cooperative agreements, which lessen regulatory actions, inspection, and enforcement in accordance with the effectiveness of self-regulation.

OTHER, RELATED GOVERNMENT REGULATIONS

The part 503 Sludge Rule and state regulations for agricultural irrigation with treated effluent work within a much larger framework of regulations. To assure that adequate in-stitutional controls address residual risk, it is important to understand the relationships between the various regulatory programs other than those that deal strictly with agricultural use of municipal wastewater and sludge. In this regard it is important to keep in mind two concepts. First, all of society's wastes eventually become reassimilated within our environment, and there-fore possess a potential for adverse impact to humans. Second, existing institutional programs and other factors, such as liability, have thus far mitigated most risks from the use of treated wastewater and sewage sludge, and, in the case of sludge, these programs are now being supplemented by beneficial use management options in the Part 503 Sludge Rule.

This section of the report illustrates the relationship between federal programs to show how the seemingly unrelated programs combine to achieve a protective strategy that mitigates potential residual risks associated with municipal wastewater and sludge management.

Toxic Waste Segregation, Waste Collection, and Treatment

Figure 8.1 illustrates some of the processes in the wastewater and sludge lifecycle generally addressed by federal and state environmental regulations. Management of municipal wastewater begins before treatment through source control and pollution prevention programs. Residential sources are managed through separation of storm water from sanitary wastewaters and by public education that promotes responsible behavior towards hazardous material disposal. Pollution from industrial wastewater sources is regulated through limits on certain toxic substances entering the municipal wastewater (40 CFR 129), and specific industrial effluent quality standards assigned to particular types of industries (40 CFR 400-471). Many industries also employ voluntary programs to recycle or recover materials in industrial processes that would otherwise pollute the waste stream. Additional protection is indirectly provided by the Toxic Substances Control Act (40 CFR 700-799), which describes specific use requirements for many chemical substances. Wastewaters from residential and industrial sources are conducted through the common, public sewers. Discharge of the wastewater into surface waters is regu-lated by state permits under the National Pollution Discharge Elimination System (NPDES) program (40 CFR 122-125).

Solid waste collected from residential, commercial and institutional sources is separated from other wastes (40 CFR 256-259) and is subject to treatment, storage, and volume reduction (40 CFR 264), or materials recovery (40 CFR 245). Solid waste classified as hazardous material are identified, transported, and processed under more stringent criteria (40 CFR 260-280).

Control over these various forms of municipal wastes has been instrumental in improving the quality of effluent discharged from municipal wastewater treatment systems and in meeting the performance criteria established by NPDES. These various controls also create conditions that can improve the quality of sewage sludge, and increase the likelihood of meeting the standards required by the Part 503 Sludge Rule. If it were not for this regulatory framework and investment by industry, beneficial use of sludge would not be a viable option.

If the quality of sludge does not meet beneficial use criteria, it must be disposed as re-quired under the Part 503 Sludge Rule or, if mixed with non-hazardous solid waste, managed under existing state solid waste plans (40 CFR 256 and 258). Sewage sludge is now regulated under the solid waste rules only if it is mixed with municipal solid waste and disposed of by means not covered under the Part 503 Sludge Rule, which otherwise covers all land application of sewage sludge. In this regard, the credibility of sludge beneficial use programs may be improved if EPA and states assign authority to local government solid waste regulators for

FIGURE 8.1 Some of the processes in the wastewater and sludge lifecycle generally addressed by federal and state environmental regulations.

responding to any reports of inappropriate activities related to beneficial reuse of sludge, such as excessive application, odor, or illegal dumping. Some of the negative public reaction to land application of sludge may be due to an erroneous public belief that prohibited materials may now be land applied.

Treated Effluent and Sludge Discharge Management Options

In the regulatory framework diagram illustrated by figure 8.1, treated municipal waste-water effluent can be managed through two options: disposal to a surface water discharge point assigned by the NPDES permit (40 CFR 122-125), or by meeting state standards for land treatment, land disposal, or wastewater reuse. Usually, additional pathogen attenuation and/or crop selection and harvest restrictions are imposed if the effluent will be applied to crops in-tended for human consumption.

Treated sewage sludge can be managed for either disposal or beneficial use. Sludge can be disposed under established solid waste programs (40 CFR 240-299) if disposed into solid waste disposal facilities controlled by these programs, or it can be disposed or beneficially used under the requirements of the Part 503 Sludge Rule (EPA, 1993). As described in Chapter 3, the sludge may be applied to agricultural land for beneficial use if the trace element pollutant concentrations are low enough and if pathogen and vector attraction reduction methods are employed.

Surface and Ground Water Protection

Figure 8.2 shows the processes in food production and solid waste management generally addressed by federal and state regulations and by guidelines related to surface and ground water protection, especially those used for drinking water. Many programs have been established to mitigate adverse impacts from nonpoint sources. The U.S. Department of Agriculture (USDA) through the Natural Resource Conservation Service (NRCS), provides technical assistance and controls to mitigate adverse environmental impact related to agriculture. Most of these programs are established through the NRCS (7 CFR 600-611) and they support activities such as environ-

FIGURE 8.2 The processes in food production and solid waste management generally addressed by federal and state regulations and guidelines related to surface and ground water protection.

mental services, conservation, and watershed protection (7 CFR 650-658). Many of these programs are specifically designed to minimize erosion and contaminant runoff from agricultural land (7 CFR 799, 7 CFR 3100, 7 CFR 3407). Erosion control programs can minimize the amount of soil loss (along with any surface-applied sludge) that may occur from land application sites.

Crop selection and nutrient application advice by state and local extension agents help farmers to minimize ground water contamination from nitrate leaching. As discussed in Chap-ters 4 and 6, unsaturated soil is capable of attenuating many contaminants in sludge and wastewater if they are applied according to crop requirements. The contaminants in sewage sludge tend to be immobile and not available for leaching to ground waters. In this context, the use of wastewater and sludge is no different than other agronomic inputs that should be considered in watershed management and in the protection of ground water resources. When drinking water is drawn from surface or ground waters, it is subjected to maximum contaminant and treatment performance criteria under the National Primary and Secondary Drinking Water Standards (40 CFR 141-143). If public drinking water does not meet mandatory requirements, suppliers must provide notice to customers (40 CFR 135).

Public Health Protection for Harvested Crops

When EPA first promulgated criteria for land application of sewage sludge to cropland in

1979, some food processors raised a series of questions about the perceived safety and legality of food crops grown on sludge-amended soils, and the adequacy of procedures to properly manage the application of sewage sludge to land used to grow fruits and vegetables. The principal federal agencies involved—EPA, the FDA, and the USDA—developed a joint statement of federal policy and guidance on the use of sewage sludge in the production of fruits and vegetables in 1981 (EPA, 1981) to provide assurances to the food industry that the high quality of food would not be compromised by the use of treated municipal sludges with adherence to proper management practices. However, the food processors were not convinced (National Food Processors Association, 1993) as earlier discussed.

Neither USDA nor FDA have specific regulations for the use of sludge or reclaimed water in food crop production, but rely on existing regulatory programs involved with the con-sumption of animal products and foods that are commercially processed or receive cooking in commercial establishments (illustrated by Figure 8.3). Food processors and retailers normally operate under the assumption that all raw meat has pathogens and handle it accordingly. The principal regulatory protection for meat that is cooked at home is the USDA meat inspection program (9 CFR 301-391). The USDA requires mandatory inspection for all meats and meat products under 9 CFR 301-335, and has the enforcement capability to act on criminal offenses. However, since meat is a perishable commodity, improper preparation or handling of meat can encourage the growth of pathogens and toxic substance even after inspection. Therefore, consumers need to be educated as to the hazards involved in meat preparation and cook meat thoroughly. The food industry and health regulators educate the public to raise awareness of the food-borne illness risk associated with any improper food handling practices. No regulatory program can be expected to eliminate this risk, and vigilant cooking practices are necessary for health protection regardless of whether a beneficial sludge or wastewater program is in effect.

Standards for inspection and certification of fresh fruits, vegetables and other processed food products are provided under 7 CFR 51-75. Standards related to the condition of containers and their inspection are established under 7 CFR 42. FDA is directly involved with regulatory controls over food processing practices for harvested foods under 21 CFR 100-199. These regulations address issues of specific food labeling, standards for quality, unavoidable contaminants in food for human consumption (21 CFR 109) and help assure that "Good Man-ufacturing Practices" are applied during manufacturing, packing or holding human food (21 CFR 110). The Good Manufacturing Practices (21 CFR 110) are an extremely effective self-regulatory control mechanism where specific regulations do not exist. They require the use of only wholesome, unadulterated products and the best handling methods possible. If a consumer of a processed food becomes ill and the episode is traced to a problem during food processing, the company will be measured against this standard as part of the basis for assigning liability. Enforcement policies and methods for dealing with criminal violations are covered by 21 CFR 7. These regulations guide production processes and use of additives, and establish lists of direct and indirect food substances that can be considered safe additives (21 CFR 184-186). Substances prohibited from use in human food, or prohibited from indirect addition to human food through food contact surfaces, are also evaluated and listed (21 CFR 186-189).

FDA, acting under the authority of the Public Health Service Act (42 U.S.C. 243 and 311) and the Economy Act (31 U.S.C. 686), developed a Model Food Code. Each edition of the code incorporates the latest and best scientifically based advice available for preventing foodborne illness. The Model Food Code has been adopted by local, state, territorial, tribal, and federal agencies who are responsible for inspecting and enforcing federal, state, and local laws related to safe food handling practices at the retail level. Assistance in implementing the code is provided by the FDA under the Federal Food, Drug and Cosmetic Act (21 U.S.C. 301). This may be the most important protective activity that exists within the regulatory framework because it promotes uniform implementation of national regulatory policy for food at retail establishments throughout the United States.

Uncooked food sold by retail establishments and food consumed at home by the public is not directly protected by the Model Food Code. Vegetables that may be consumed uncooked need to be properly handled, regardless of whether or not beneficial reuse practices are imple-

FIGURE 8.3 Some of the Processes in Food Crop Harvest and Food Production that are Addressed by Federal and State Regulations and Guidelines.

mented. In general, fresh produce requires a higher level of protection from pathogenic con-tamination during harvest, transport and storage than do crops destined for commercial processing. The Part 503

Sludge Rule requires farmers who grow produce crops to adhere to rigid cropping and harvesting practices if Class B municipal sludge is land applied. The federal regulations require a statement by farmers that they have complied with the restrictions on cropping and harvest. However, no training or certification is required for farm workers, nor is any compliance inspection or surveillance included in this program.

Protecting food during transport is another critical aspect of food safety. Food products that are intended for direct human consumption or for indirect consumption, such as feed for grazing animals, may be contaminated from a variety of sources during transport for dis-tribution. If harvested crops were "backloaded" in vessels used to transport Class B sludge, crops could be exposed to pathogens. Congress has provided agencies with the authority to deal with this problem by enacting the Sanitary Food Transportation Act of 1990 (Public Law 101-500). Section 4 of this act requires (1) appropriate record keeping, identification, marking and certification or other means to ensure compliance. (2) appropriate decontamination. Section 5 prohibits transportation of food products in cargo tanks, rail cars and tank trucks that are used to transport nonfood products that would make food unsafe to the health of humans or animals. The existence of the this law, properly enforced, should act as a deterrent that would minimize the potential of backhauling harvested food products in vehicles that were previously used to transport sewage sludge to agricultural areas.

Analysis for Regulatory Gaps and Overlap

An evaluation of the framework reveals that many existing regulatory controls are available to protect the environment and public health. Federal regulations governing drinking water are generally considered to be credible. Harvested crops that are cooked and handled by retail operations are also subjected to numerous, specific regulatory controls that have achieved public credibility and trust due to surveillance and enforcement. Agricultural crops irrigated with treated municipal effluents may be even better protected than those irrigated with local surface waters due to stringent regulatory standards imposed by state authorities on the quality and reliability of effluents.

Industrial pretreatment and source control programs have been effective in minimizing trace element contamination of municipal wastewater. These programs have been effective because of a combination of industry self-monitoring efforts, surveillance and enforcement activity by government regulators, and lawsuits by citizen action groups. The Part 503 Sludge Rule has been adopted as a result of the credibility achieved by the control over trace element contaminants in wastewater entering municipal treatment works.

Applying sludge that is not pathogen-free raises the possibility of foodborne illness. Food quality is regulated by a host of specific standards imposed on retail operations (food processors, distributors, and restaurants) by the FDA and state health agencies charged with the respons-ibility for inspecting and enforcing public health regulations. These stringently enforced, costly controls have been responsible for achieving extremely high expectations of food quality by the American public. Even in cases where specific operation standards do not exist, processors and retailers are still constrained by "Good Manufacturing Practices" that require all possible effort to protect health. If they are charged by a civil or criminal suit, they must be able to prove that "Good Manufacturing Practices" were employed. Failure to do so can be costly for an industry. The standards assigned to the use of Class B sludge emphasize site restrictions and farm management practices, as opposed to the treatment or microbial quality criteria that defines Class A sludge. Questions have been raised over whether Class B sludge management practices pre-sent a credible program for monitoring and enforcement. If the POTW is not actively involved with management aspects, then reliance is placed on contractors and farmers to comply with the necessary site and harvesting restrictions. This is not of immediate concern for crops that undergo processing operations because of the existing food processing safety standards imposed and enforced by FDA. Also, retail establishments are obliged to follow proper cooking procedures according to the "Food Code." However, neither of these regulatory controls will protect the health of those who consume uncooked vegetable crops in retail establishments (e.g. salad at a restaurant) or prepared at home. If management standards for Class B sludge are not followed for fresh produce crops that can be eaten raw, public health could be compromised. Public confidence in the use of Class B sludge could be improved by more explicit involvement of local or state public health authorities. In matters of infectious disease control, public health agencies can quickly step in with immediate consequences for non-compliance, which can include public notice, fines, immediate cessation of operation, and/or product recall as necessary. In contrast, environmental authorities typically impose fines and may allow of-fending conduct to continue. Additionally, food safety programs normally require personnel training and certification. If municipal treatment systems wish to introduce a product of value to the agricultural and food community, that product must not be perceived as a risk to consumers. The only means to ensure this is to (1) demonstrate that the applied material is safe to handle and meets high-quality pollutant and pathogen limits so that minimal oversight is necessary after land application, or (2) assure that all personnel associated with transport, application and use of sludge are trained and certified, and maintain accessible records to reassure interested parties that pathogens and chemical pollutants are being managed effectively.

SUMMARY

Economic incentives play an important role in decisions to pursue beneficial land ap-plication of reclaimed wastewater and treated sludge. In many cases there are clear economic incentives for society as well as POTWs to pursue beneficial use options, even though revenues from these projects will often be small or nonexistent. With the exception of water-short areas, there are only limited incentives for farmers to apply reclaimed wastewater and sludge, due to the low cost of alternative sources of nutrients and water. Thus, subsidies may be appropriate where regulatory costs associated with reclaimed wastewater and sludge application exceed beneficial use values. However, subsidy programs should be structured to avoid creation of incentives to apply effluent or sludge at rates in excess of crop requirements.

There are only negligible economic incentives for food processors to accept products produced with reclaimed wastewater or sludge. Benefits in terms of lower raw food costs are likely to be minimal, whereas the risks from negative public perception could be substantial. Negative public perception of food crops produced using treated wastewater or sludge could have detrimental impacts on consumer demand and the profit and survival of firms.

Despite the existence of extensive regulations, public perceptions of significant risks associated with beneficial land application persist in some areas. Extensive evidence has shown the importance of public education and early involvement in the design of beneficial land application for successful implementation of reuse programs. In addition, a number of private sector forces deter inappropriate behavior by the various parties involved in beneficial reuse pro-grams. These forces include common law liability, market forces, and voluntary self-regulation (e.g. codes of conduct, worker training and certification, audits).

Sectors of society that are hesitant, or may become hesitant, to endorse the concept of beneficial use of wastewater and sludge in food crop production—the food industry, farmers, product consumers, and adjoining property owners—will need to have evidence of adequate surveillance and enforcement of the existing suite of pollutant criteria, process standards, and management requirements. This is especially important for use of Class B sludge on produce crops. One way to maximize program credibility is to require training and certification for members of the agricultural community who use Class B sludge to grow crops for human consumption.

From a regulatory perspective it is important to remember that the Part 503 Sludge Rule and state regulations governing the agricultural use of reclaimed wastewater merely augment a wide array of existing institutional programs and controls that have responsibly mitigated risks from these practices in the past. Related regulations pertain to toxic waste handling and treatment, surface and groundwater protection, and public health. These regulations and their overlapping authority are complex and need to be adequately explained to both the regulatory community and the interested public to avoid confusion and the perception that beneficial use is a disguise for the dumping of wastes. Although some clarification and streamlining of the Part 503 Sludge Rule would be beneficial, the regulatory framework appears generally adequate to manage risks associated with land application of both treated municipal wastewater and treated sewage sludge.

The suite of existing federal regulations, available avenues for additional state and local regulatory actions, and private sector forces appear adequate to allow, with time and education, the development of safe beneficial reuse of reclaimed wastewater and sludge. In fact, there are many such programs already in operation.

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